

REMARKS

Claims 1-23 were in the case. Claims 13-21 and 23 were previously withdrawn in response to a restriction requirement; claims 1, 9, 10 and 22 are amended herein; and claims 24-26 are newly added herein. *Support for the amendments to the claims can be found at least at paragraph [0056] of the original disclosure and in the original claim set. No new matter is added.*

Claims 1-12, 22 and 24-26 are currently pending in the case for examination.

1. Claim Rejections Under 35 U.S.C. § 112

In paragraph 2 of the Office Action, claim 22 was rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Specifically, the Office Action asserts that there is insufficient antecedent basis for the term “the mixture” in claim 22.

Claim 22 has been amended herein to change the term “the mixture” to “the etchant.” Applicant submits that there is antecedent basis for the term “the etchant” in claim 22. Therefore, Applicant respectfully submits that the rejection of claim 22 under 35 U.S.C. § 112, second paragraph, has been overcome. Applicant respectfully requests that the rejection of claim 22 under 35 U.S.C. § 112, second paragraph, be withdrawn.

2. Claim 22 is Patentable Over Yokomizo

In paragraph 3 of the Office Action, claim 22 was rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent Application Publication No. 2002/010285 (“Yokomizo”). Specifically, the Office Action cites Yokomizo as teaching “a method to etch semiconductor wafers having a silicon oxide and silicon nitride layer (page 2, paragraph 0028) providing a closed-loop circulation system having a bath 11/process chamber and a recirculation line fluidly coupled to the process chamber (page 2, paragraph 0035) supplying a predetermined volume of an etchant mixture to the closed-loop circulation system, the etchant filling the process chamber and overflowing into the recirculation line (page 2, paragraph 0034; page 4, paragraphs 0053-0054, fig. 1)

submerging at least one substrate in the etchant within the process chamber (page 3, paragraph 0048) circulating the etchant mixture through the closed-loop circulation system (page 3, paragraph 0049) continuously measuring substance dissolving from a surfaces of wafer into the etching liquid (Si)/particle counts in the mixture with a detecting means/particle counter, (page 3, paragraphs 0042, 0050) upon detecting the etchant having a measured particle count above a predetermined particle count, automatically discharging/bleeding a volume of contaminated etchant from the closed-loop circulation system while replacing the volume by feeding fresh etchant into the closed-loop circulation system during the processing of the at least one substrate that will return the particle count of the etchant within the closed-loop circulation system to or below the predetermined particle count (page 4, paragraphs 0058-0059).” Applicant respectfully submits that this rejection is improper for the reasons discussed below.

As an initial matter, Applicant notes that claim 22 is only amended herein to correct an antecedent basis issue that was present in the originally filed claim and to clarify the language of the claim. No substantive amendments are made to claim 22 herein. Furthermore, Applicant notes that claim 22 requires, *inter alia*, that upon detecting that the etchant has a particle count above a predetermined level, a volume of the etchant is bled from the closed-loop circulation system while a volume of fresh etchant is fed into the closed-loop circulation system. Claim 22 also requires that the feeding and bleeding of the etchant occurs during processing of the at least one substrate. As discussed below, Yokomizo fails to teach or suggest these aspects of claim 22.

Yokomizo generally teaches an apparatus for etching and a method of etching. Figure 1 of Yokomizo is reproduced below for further discussion.

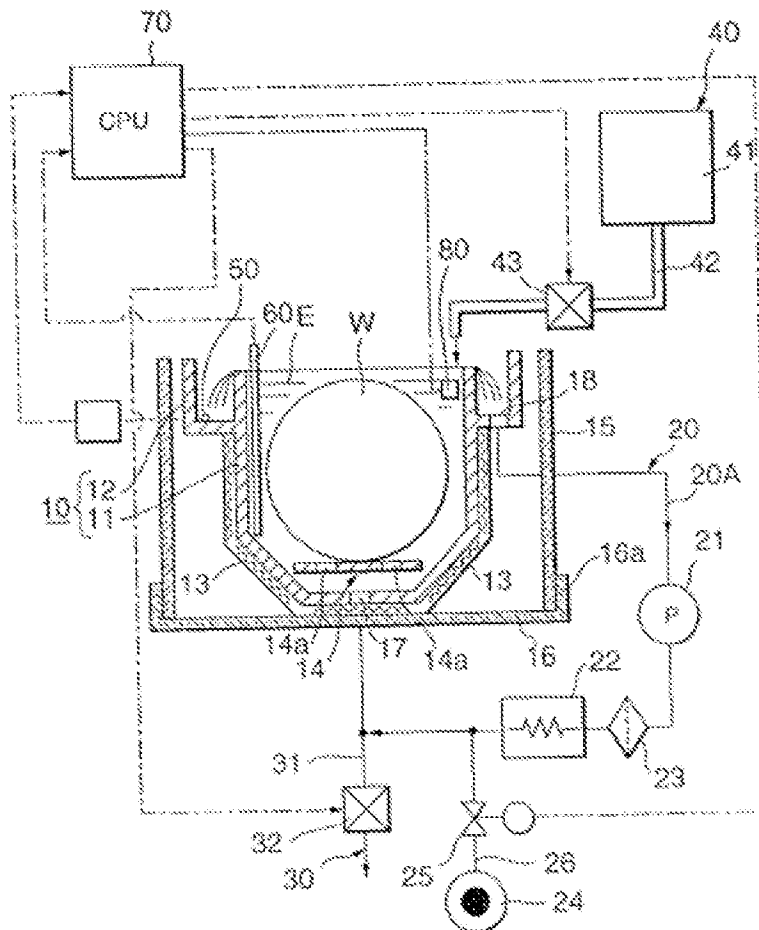


Figure 1 of Yokomizo

Yokomizo teaches a method of controlling the particle count and concentration of an etchant in a process bath. Yokomizo discloses that when the concentration reaches a predetermined upper threshold, the computer processor 70 carries out operations to maintain the concentration within a designated range. However, in Yokomizo these operations only take place “after the wafers W have been picked up on completion of the etching process and before the next wafers to be processed are accommodated in the process bath 10, that is, within an intermission between the present etching process and the next etching process.” See *Yokomizo*, ¶ [0056]. Yokomizo discloses that during this intermission period, the computer processor 70 stops the circulation of the etching liquid in the circulation system 20 by closing a valve or stopping operation of the pump 21. See *id.* at [0057]. After the wafer W has been removed from the process bath 10 and the etching liquid has stopped circulating, the computer processor 70 opens a valve 32 in the

drain system 30 to drain the etching liquid until about two-thirds of the etchant has been discharged from the inner bath 11. *See id.* at ¶ [0058]. Finally, after about two-thirds of the etchant has been removed, the computer processor 70 opens the valves 43 in the supply system 40 to allow a quantity of fresh etching liquid from a reservoir 41 equal to the quantity removed via the drain system 30 to be introduced into the inner bath 11. *See id.* at ¶ [0059]. After all of the above steps have been completed, the next batch of wafers W can be immersed in the etching liquid for treatment and/or processing.

Thus, in Yokomizo the etchant is drained from the process bath prior to introducing a fresh etchant into the process bath. In other words, in Yokomizo a fresh etchant is only introduced into the process bath after two-thirds of the used etchant is drained from the process bath. Furthermore, in Yokomizo the feeding and bleeding take place only after a wafer has been removed from the process bath. In other words, the feeding and bleeding of Yokomizo only take place while there are no wafers being processed in the process bath. Therefore, Yokomizo fails to teach or suggest “bleeding a volume of contaminated etchant from the closed-loop circulation system while replacing the volume by feeding fresh etchant into the closed-loop circulation system during the processing of the at least one substrate.”

Applicant notes that the method of the present invention is advantageous over Yokomizo. After a used etching liquid is replaced by a fresh etching liquid, it has been found that the etching rate against the oxide layer is high. In Yokomizo, by draining most of the etchant prior to introducing a fresh etchant into the process bath, the etching selectivity is not maximized. Specifically, in Yokomizo, a vast majority of the etchant is replaced during a time when no wafers are being processed. As such, Yokomizo does not completely reduce the problem of having a high etching rate against the oxide layer. In other words, because such a large amount of the etchant is replaced in the Yokomizo method, the etching rate against the oxide layer will be high when a new batch of wafers is immersed in the process bath for processing. By simultaneously draining an etching liquid from the process bath and introducing a fresh etching liquid into the process bath during the processing of a substrate, the present invention is advantageous over the prior art by reducing the etching rate against the oxide layer and increasing etch selectivity.

For at least the reasons provided above, it is respectfully submitted that the rejection of claim 22 under 35 U.S.C. § 102(b) is improper. It is respectfully requested that the rejection of claim 22 under 35 U.S.C. § 102(b) be withdrawn.

3. Claim 1 is Patentable Over the Proposed Combination of Yokomizo and Torek

In paragraph 4 of the Office Action, claims 1-9 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Yokomizo in view of U.S. Patent No. 6,087,273 ("Torek"). Specifically, with regard to claim 1, the Office Action cites Yokomizo as teaching all of the elements of claim 1 except supplying sulfuric acid, phosphoric acid and water to the circulation system. However, the Office Action cites Torek as teaching this deficiency of Yokomizo.

As an initial matter, Applicant notes that claim 1 has been amended herein for clarity only and that the amendments made to claim 1 herein are not intended to alter the scope of claim 1 in any manner. Specifically, claim 1 has been amended to recite "the feeding and the bleeding occurring during processing of the at least one substrate." The amendment to claim 1 simply clarifies the language of claim 1 regarding the feeding and bleeding occurring during processing of the substrate.

Applicant notes that claim 1 recites limitations similar to the limitations of claim 22 discussed above. Specifically, claim 1 recites feeding a mixture into the closed-loop circulation system while bleeding a volume of the mixture from the closed-loop circulation system. Furthermore, claim 1 also recites that the feeding and bleeding occur during processing of the substrate.

Therefore, for at least the reasons discussed above, it is respectfully submitted that the rejection of claim 1 under 35 U.S.C. § 103(a) as being unpatentable over Yokomizo in view of Torek is improper. It is respectfully requested that the rejection of claim 1 under 35 U.S.C. § 103(a) as being unpatentable over Yokomizo in view of Torek be withdrawn. Furthermore, at least due to their dependence on independent claim 1, it is respectfully requested that the rejections of claims 2-9 under 35 U.S.C. § 103(a) as being unpatentable over Yokomizo in view of Torek be withdrawn.

4. Claim 10 is Patentable Over the Proposed Combination of Yokomizo and Torek

In paragraph 5 of the Office Action, claims 10-12 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Yokomizo in view of Torek. With regard to claim 10, the Office Action rejected claim 10 for the same reasons as discussed above with respect to claim 1. Claim 10 has been amended herein for clarity in a manner similar to the amendment to claim 1 discussed above. Furthermore, claim 10 recites limitations that are similar to the limitations of claim 1 discussed above. Specifically, claim 10 recites “wherein the bleeding and feeding of steps (d) and (e) occur during processing of the at least one substrate.”

Therefore, at least for the reasons discussed above with regard to claim 1, it is respectfully submitted that the rejection of claim 10 under 35 U.S.C. § 103(a) as being unpatentable over Yokomizo in view of Torek has been overcome. It is respectfully requested that the rejection of claim 10 under 35 U.S.C. § 103(a) as being unpatentable over Yokomizo in view of Torek be withdrawn. Furthermore, at least due to their dependence on independent claim 10, it is respectfully requested that the rejections of claims 11 and 12 under 35 U.S.C. § 103(a) as being unpatentable over Yokomizo in view of Torek be withdrawn.

5. Summary

In view of the foregoing amendments and remarks, it is respectfully submitted that the pending claims are now in condition for allowance; early notice of which is earnestly requested. If the Examiner has any questions, or if it is believed that a phone call would expedite prosecution of this application, the Examiner is encouraged to contact the undersigned at the number listed below.

The Belles Group, P.C.

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Todd E. Klein, Esq. (Reg. No. 59,610)



Brian L. Belles, Esq. (Reg. No. 51,322)

For: **The Belles Group, P.C.**

404 S. 16th Street
Philadelphia, PA 19146
Office: 215-735-9302
Cell: 215-749-2530
Fax: 215-735-9305